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Matsumoto et al.

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(54) **CONNECTION DEVICE**

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(73) Assignee: **Idec Izumi Corporation**, Osaka (JP)

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(51) **Int. Cl.**[7] **H01R 4/48**
(52) **U.S. Cl.** **439/835**; 439/372
(58) **Field of Search** 439/834, 835, 439/836, 837, 838, 839, 372

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,679,021	A	10/1997	Kramer	439/835
6,004,168	A *	12/1999	Fuchs et al.	439/835
6,010,376	A	1/2000	Kollmann	439/834
6,270,384	B2 *	8/2001	Jaag	439/835

FOREIGN PATENT DOCUMENTS

JP	9-320657	12/1997
JP	11-86939	3/1999
WO	WO 00/21160	4/2000

* cited by examiner

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(57) **ABSTRACT**

A connector comprises locking springs **3** in which fixed pieces **31** are combined with movable pieces **32** via resilient transformed parts **33** and pushing parts **34** and in which the tips of the fixed pieces **31** are inserted into connection holes **32***a* formed in the movable pieces **32**; a case **1** for accommodating the locking springs **3**; terminal fittings **2** locating on the outer surfaces of the fixed pieces of the locking springs **3**; wire slots **11***b* formed opposite to the movable pieces **32** of the locking springs **3**; and levers **4** for pressing the pushing parts **34** of the locking springs **3**. When the lever **4** is in a non-operative position, tool entrances **11***c* are provided at an opening **11***a* which accepts the lever **4**. Each tool entrance **11***c* leads to a contact area where the lever **4** meets the pushing part **34** of the locking spring **3**.

4 Claims, 14 Drawing Sheets

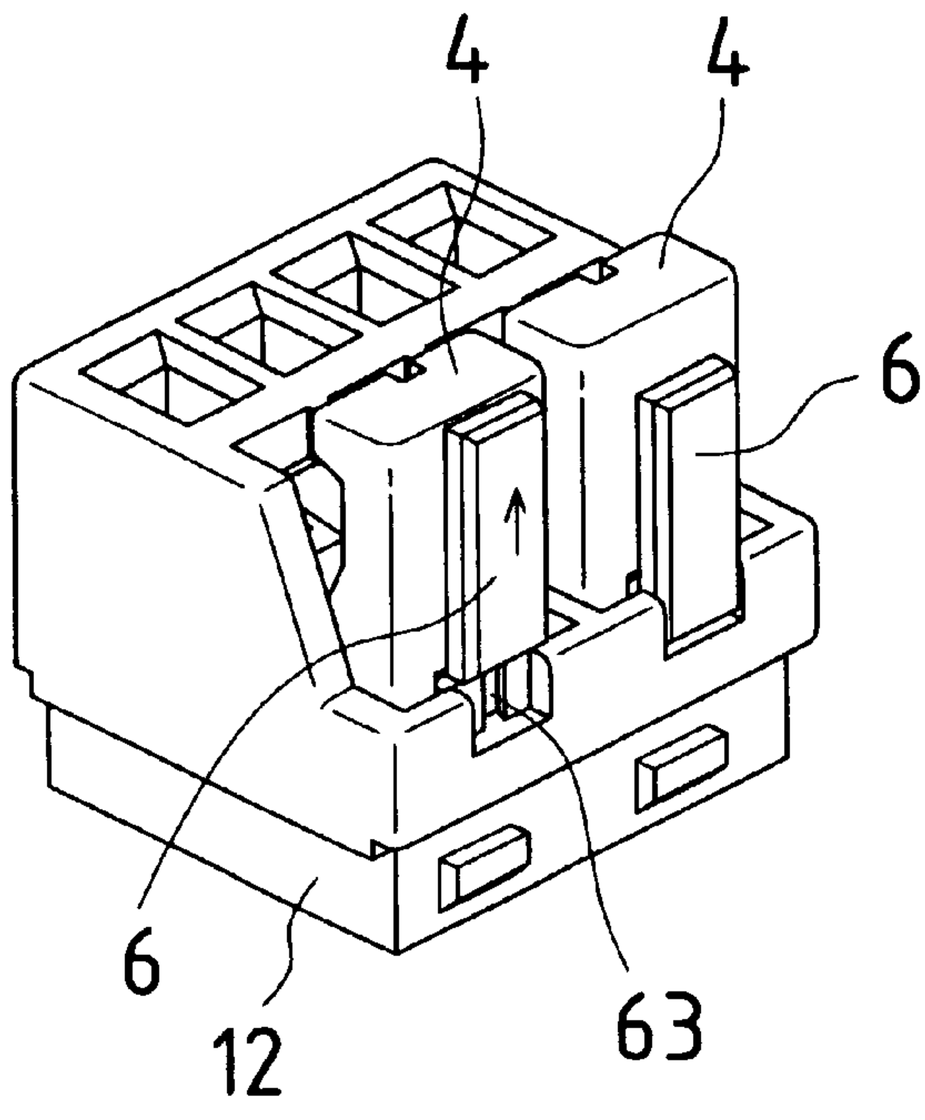


Fig.1

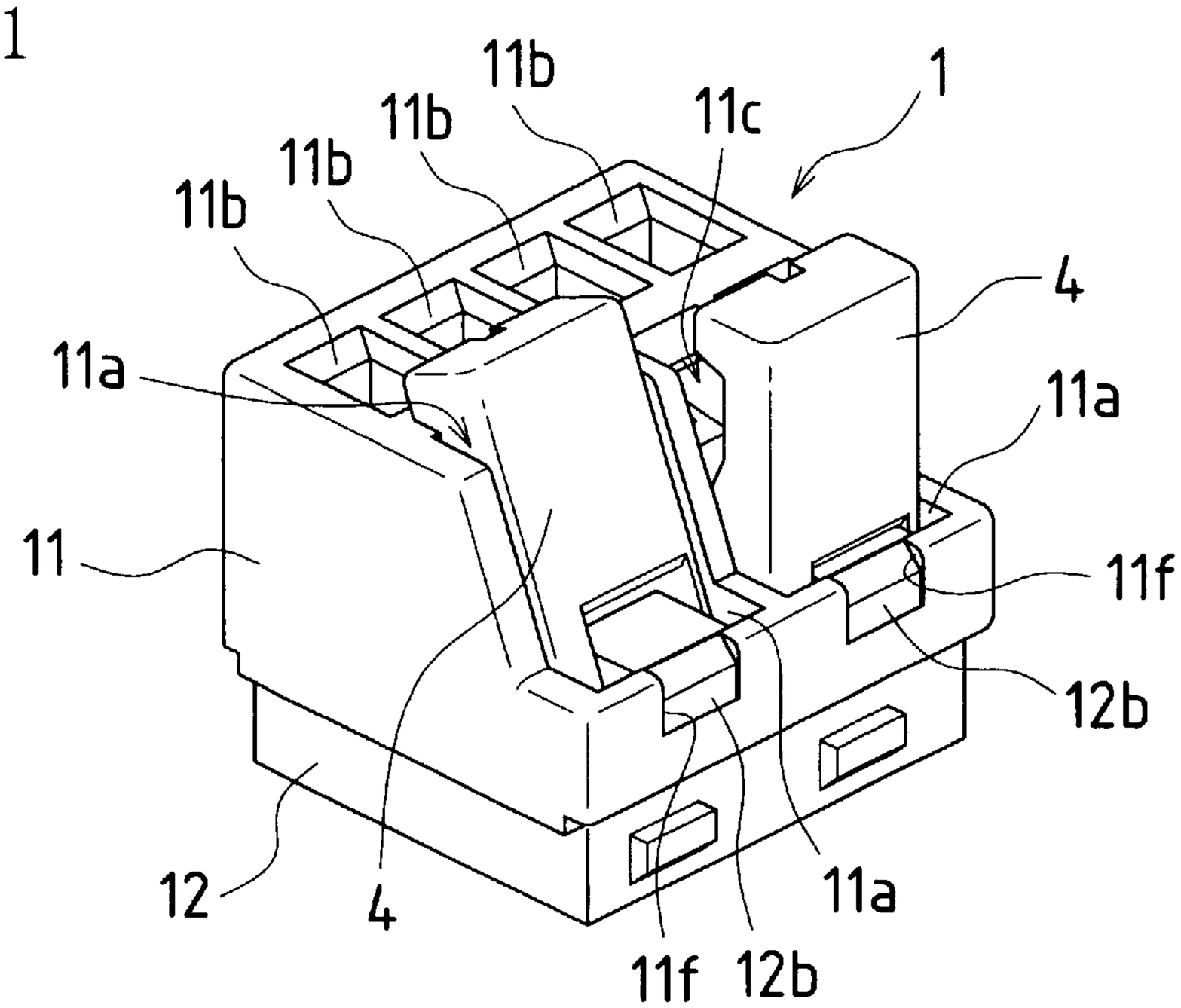

11b
11b
11b
11b
11c
1
4
11a
11a
11
11f
12b
12
4
11a
11f
12b

Fig.2

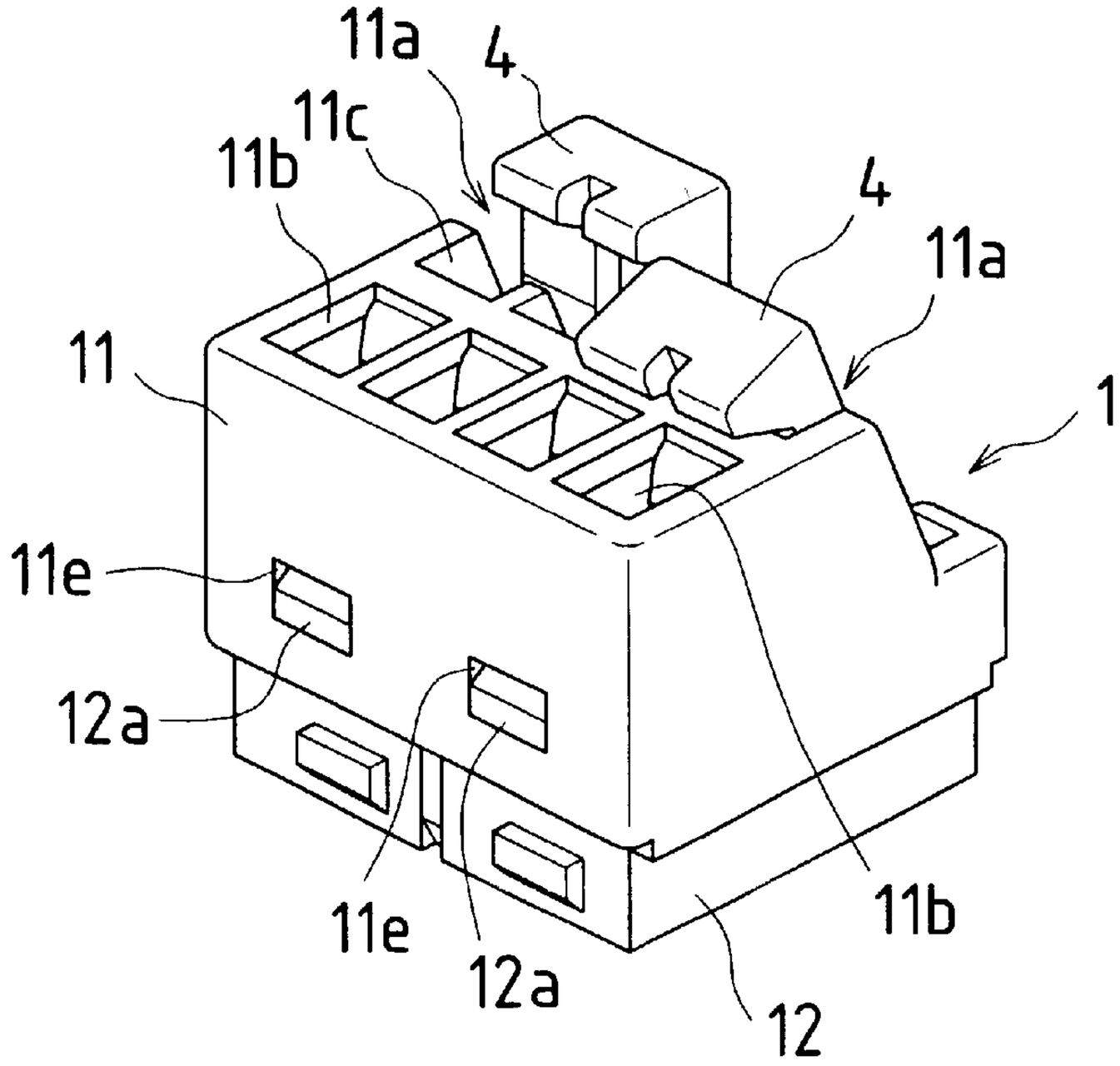

11a
4
11c
11b
4
11a
1
11
11e
12a
11e
12a
11b
12

Fig.3

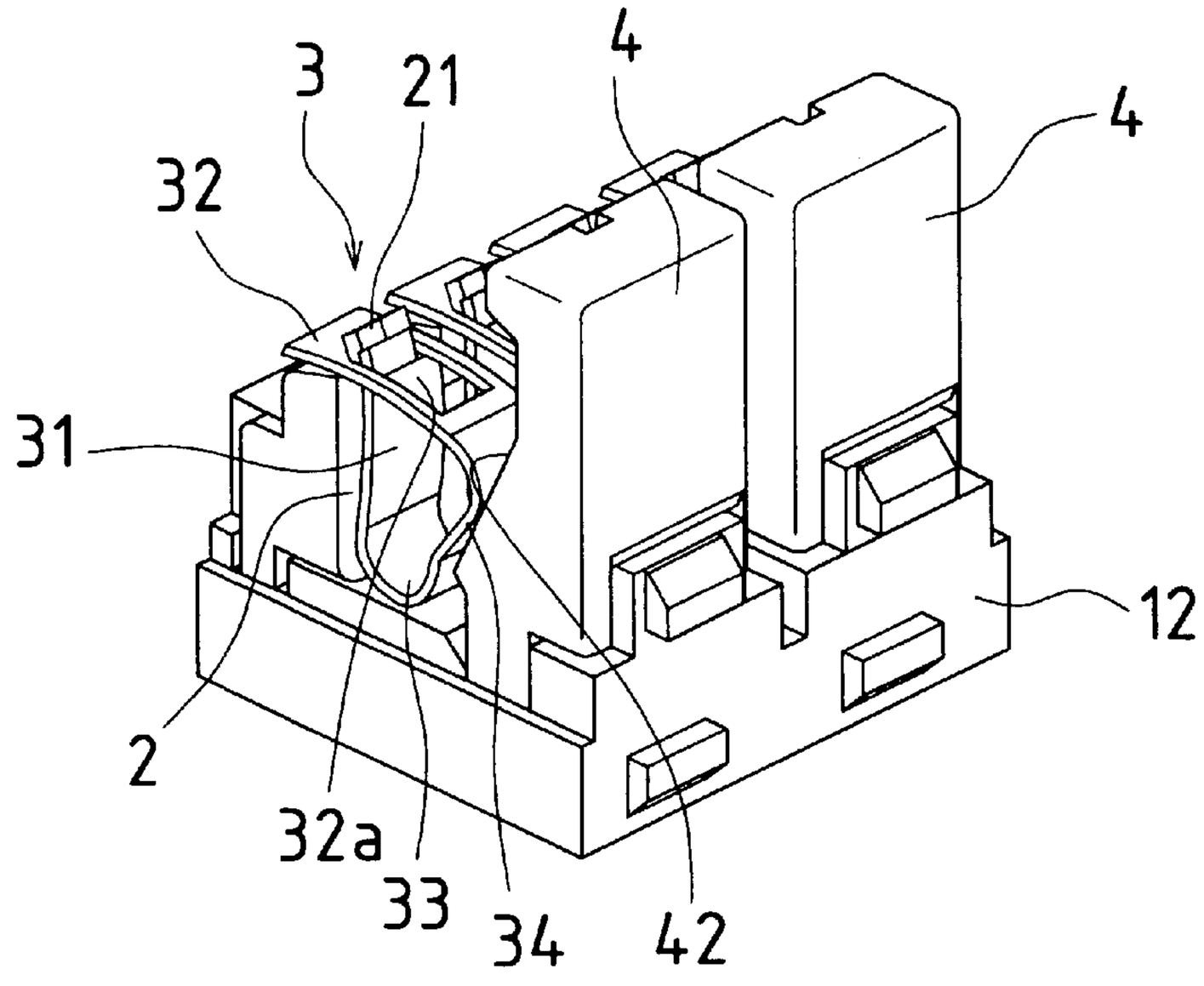


Fig.4

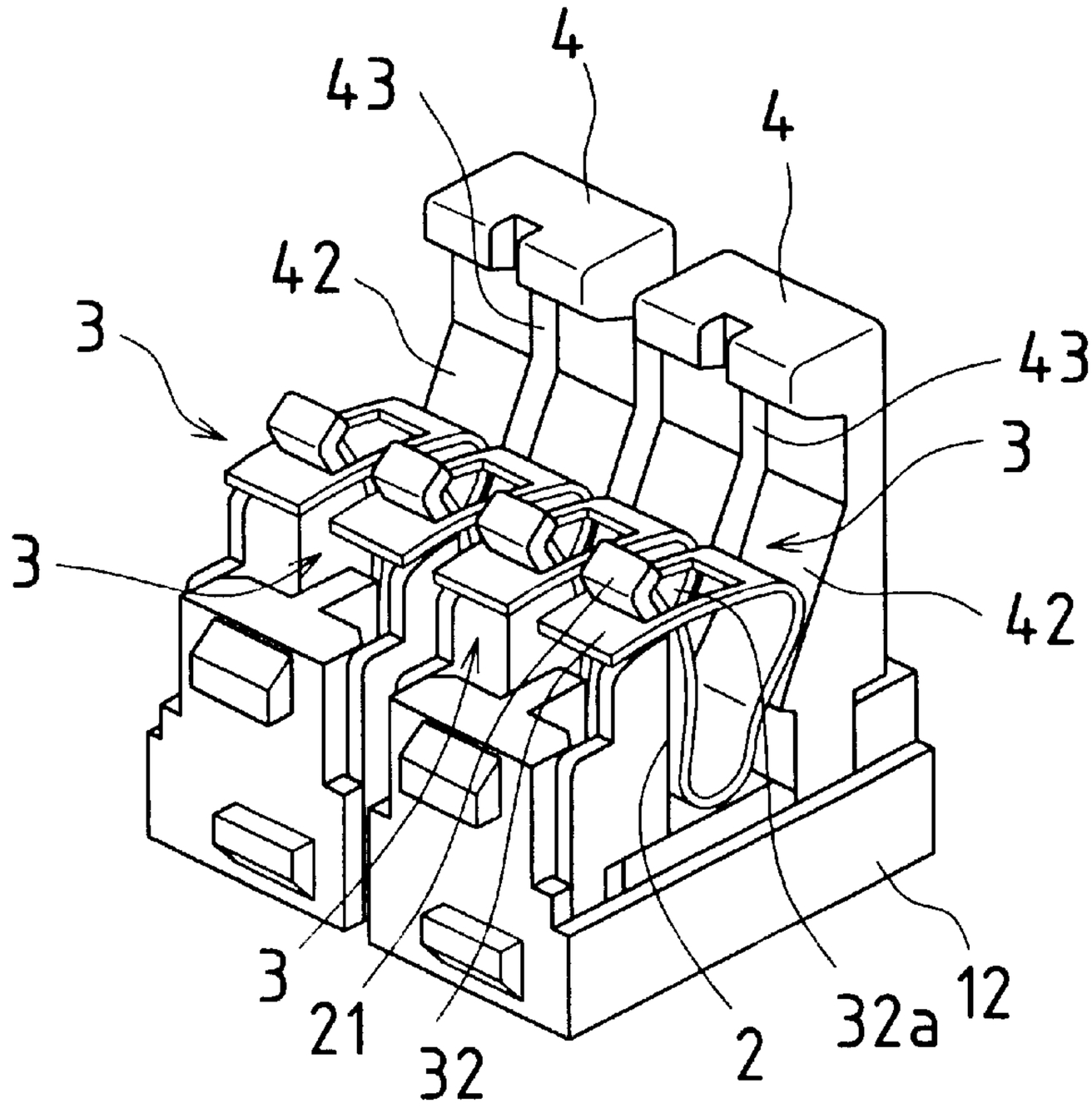


Fig.5

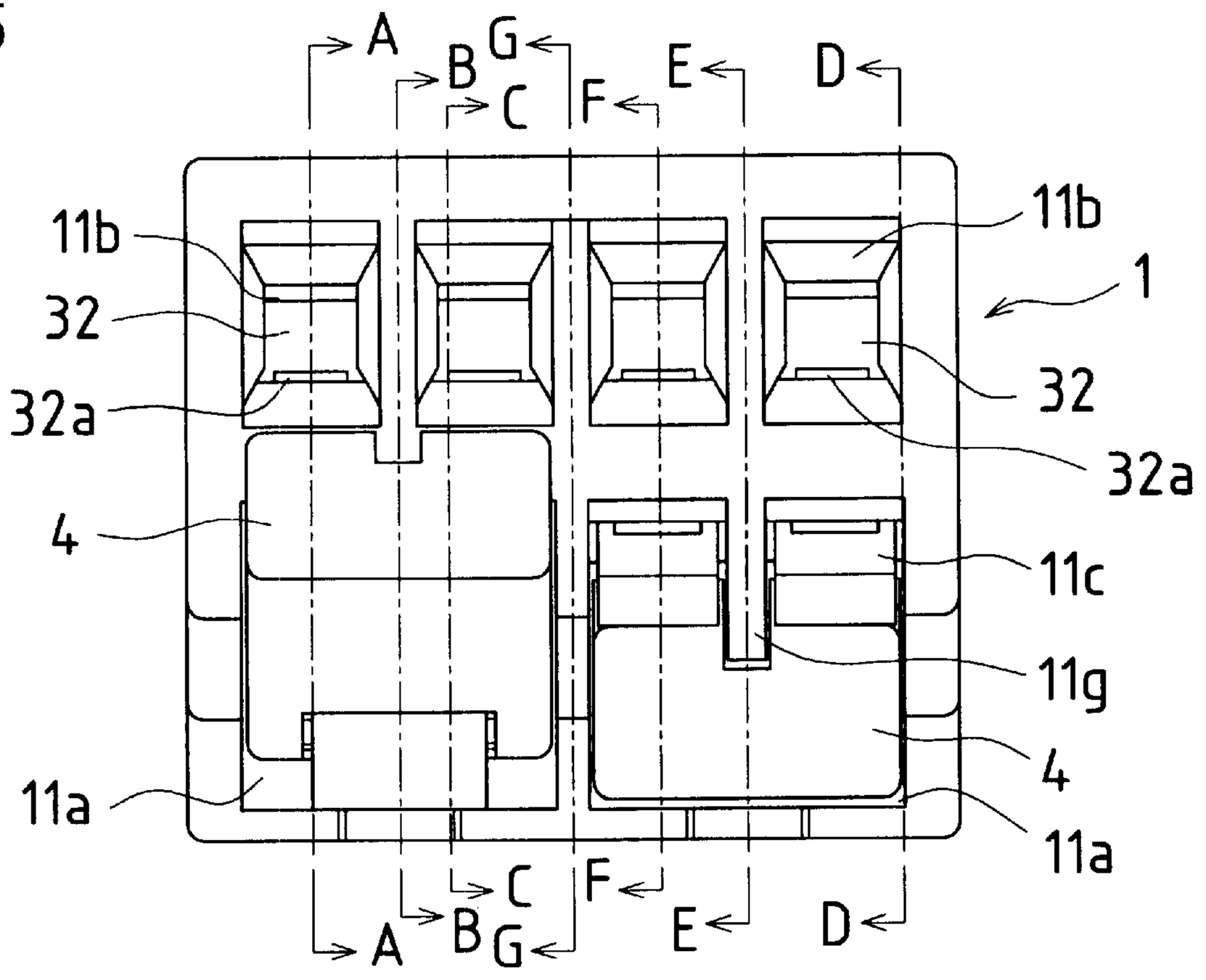

A
B
C
G
F
E
D
11b
32
32a
4
11a
1
11c
11g

Fig.6

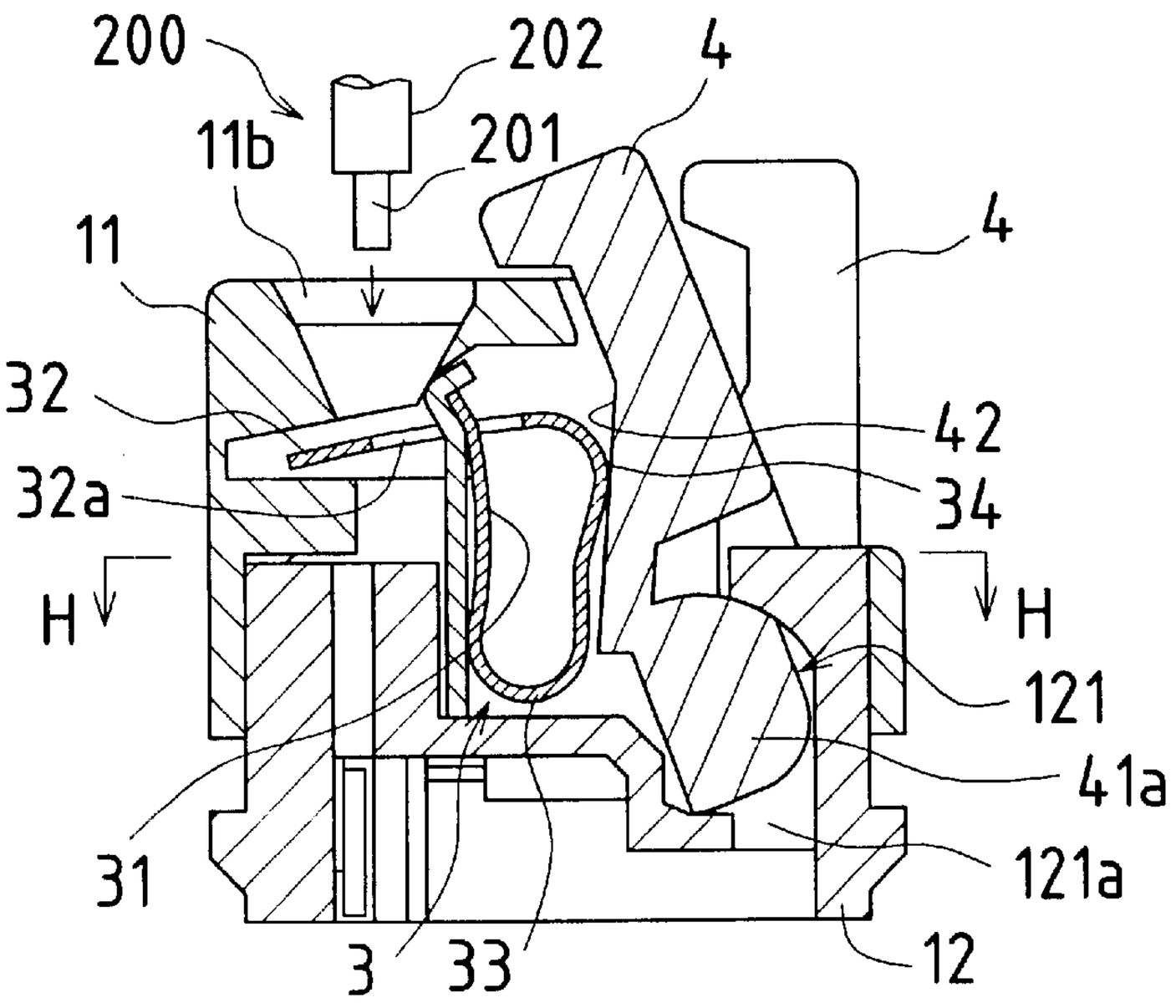

200
202
201
11b
11
4
32
32a
H
42
34
121
41a
121a
31
3
33
12

Fig.7

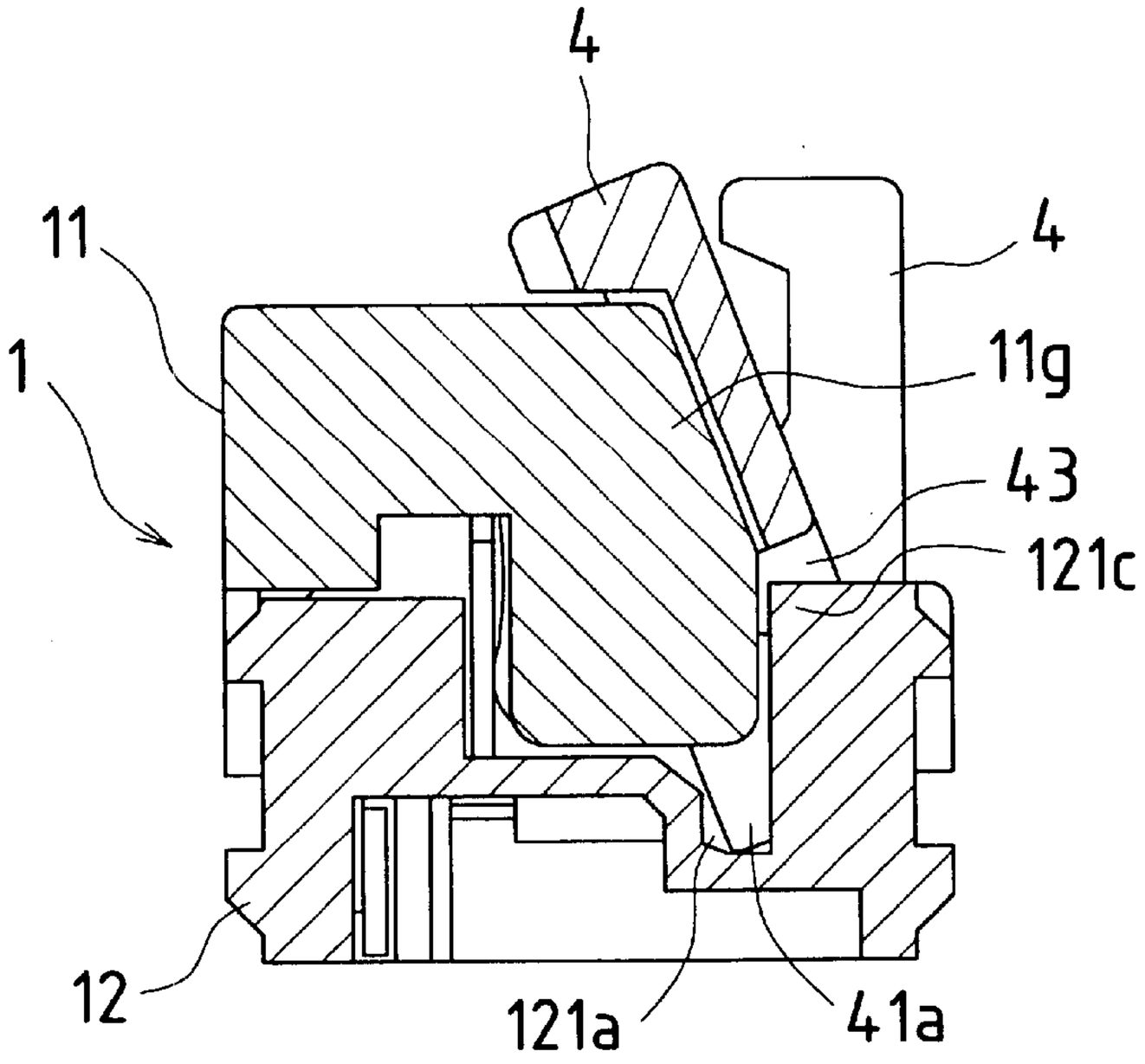

4
11
4
1
11g
43
121c
12
121a
41a

Fig.8

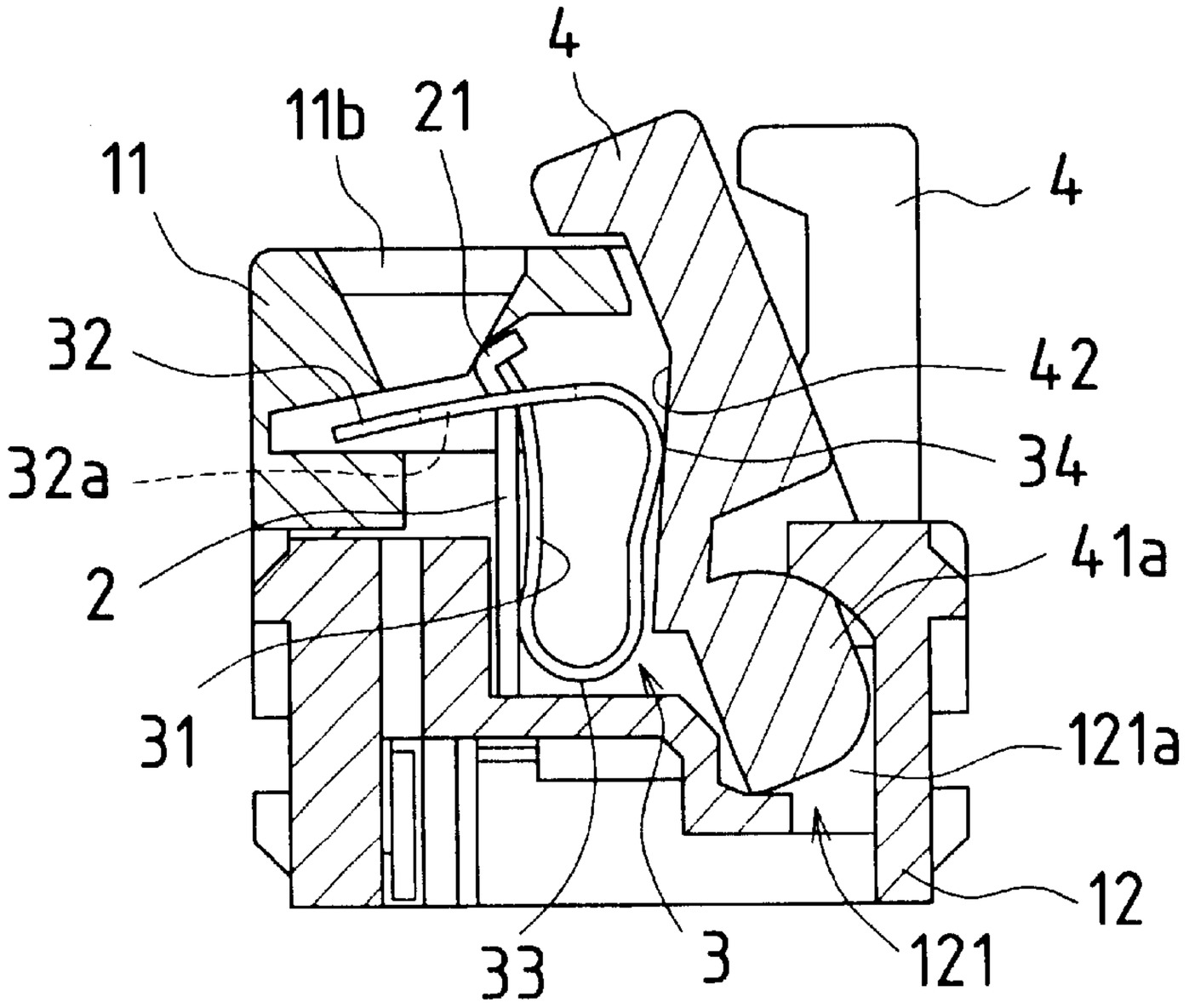

4
11b
21
11
4
32
42
32a
34
2
41a
31
121a
12
33
3
121

Fig.9

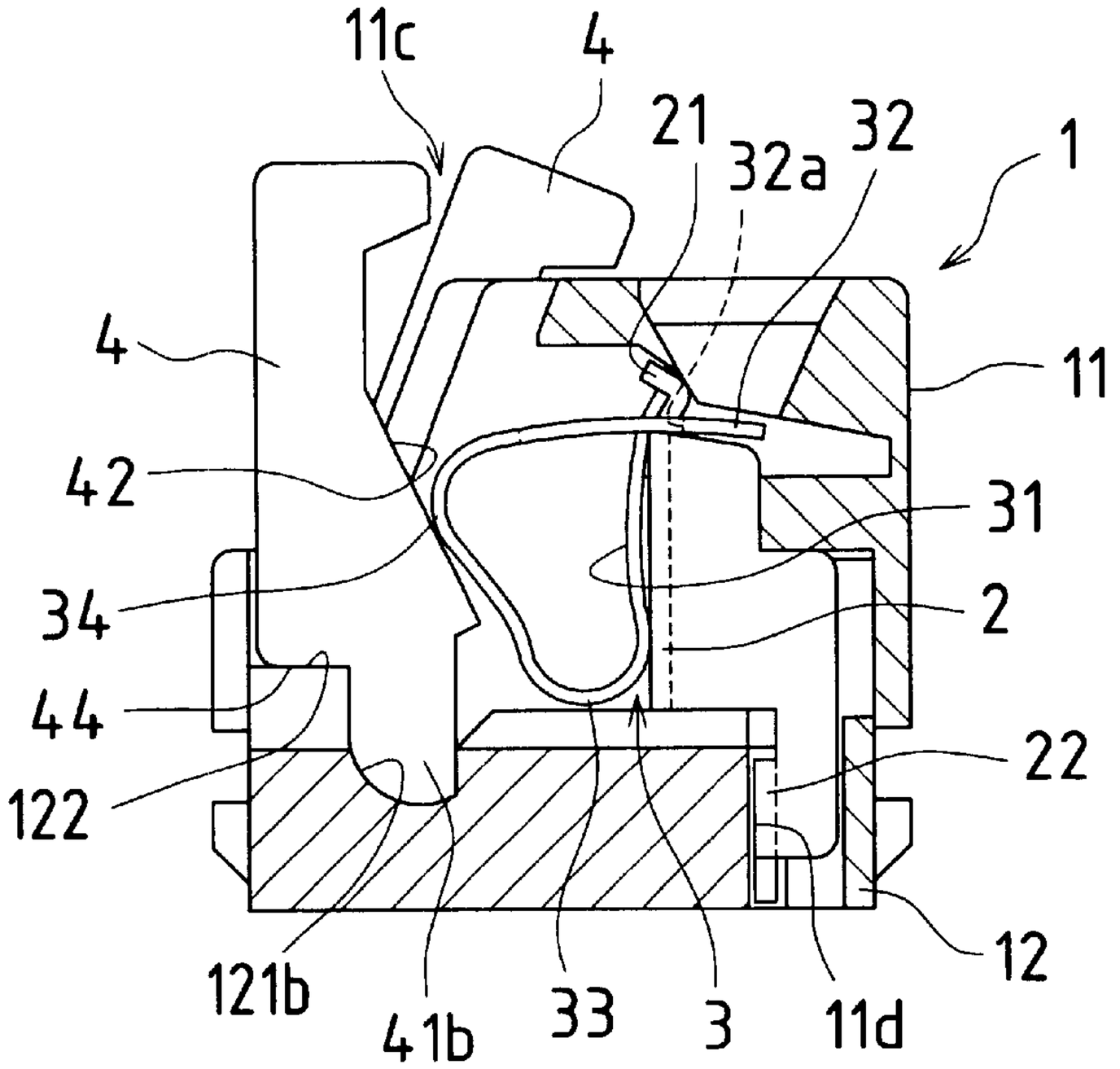

11c
4
21
32a
32
1
4
11
42
31
34
2
44
22
122
12
121b
41b
33
3
11d

Fig.10

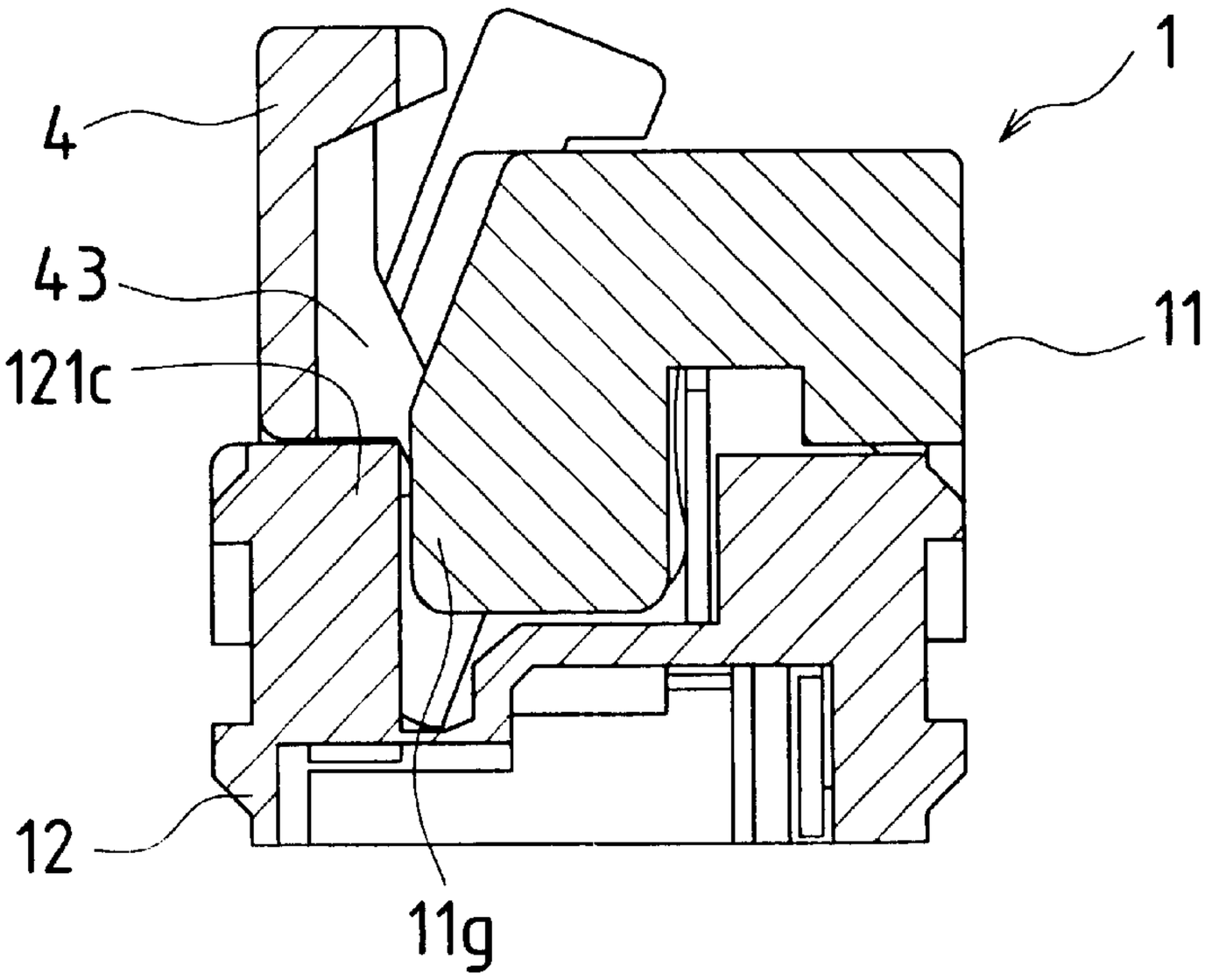

1
4
43
11
121c
12
11g

Fig.11

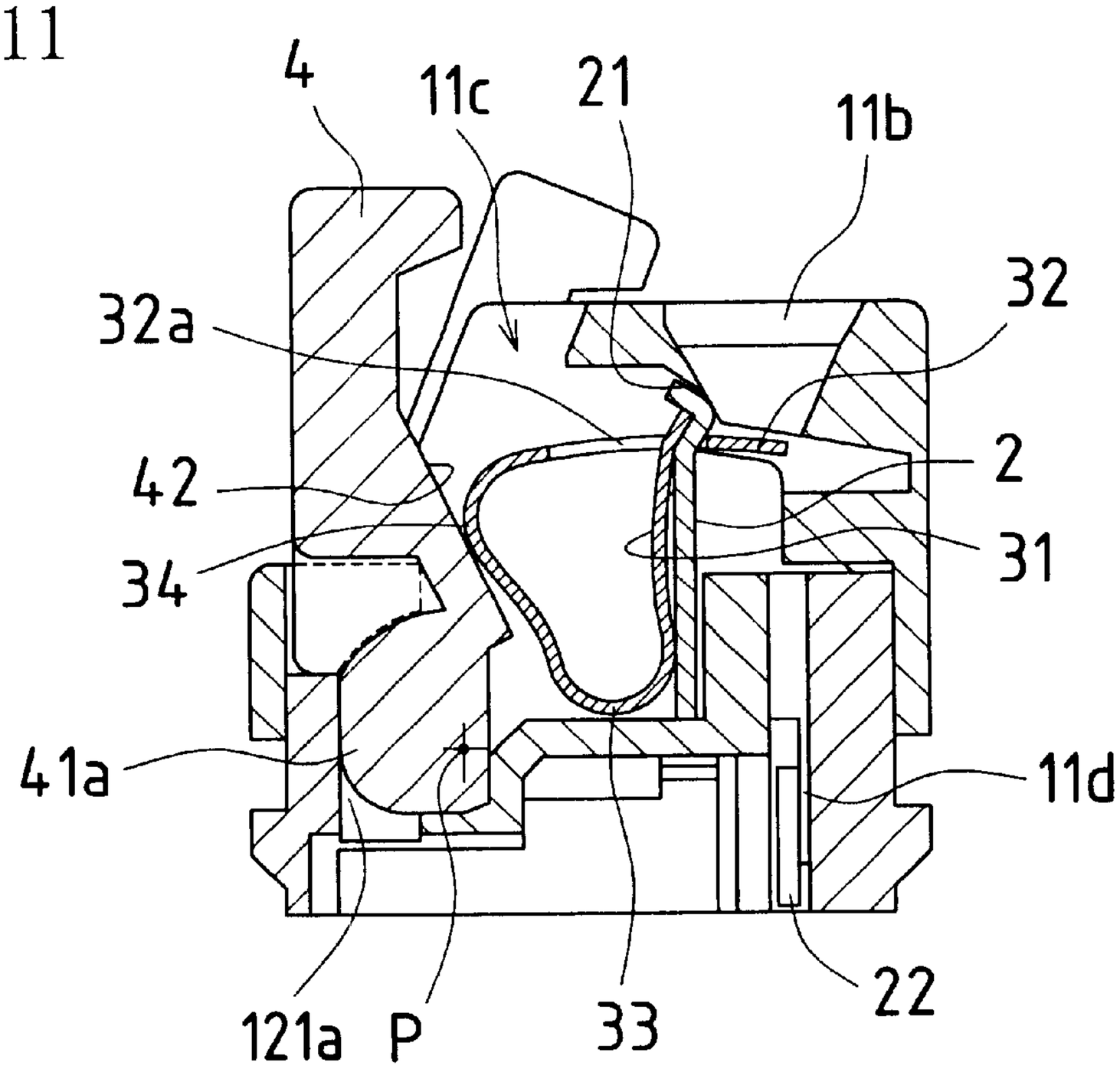


Fig.12

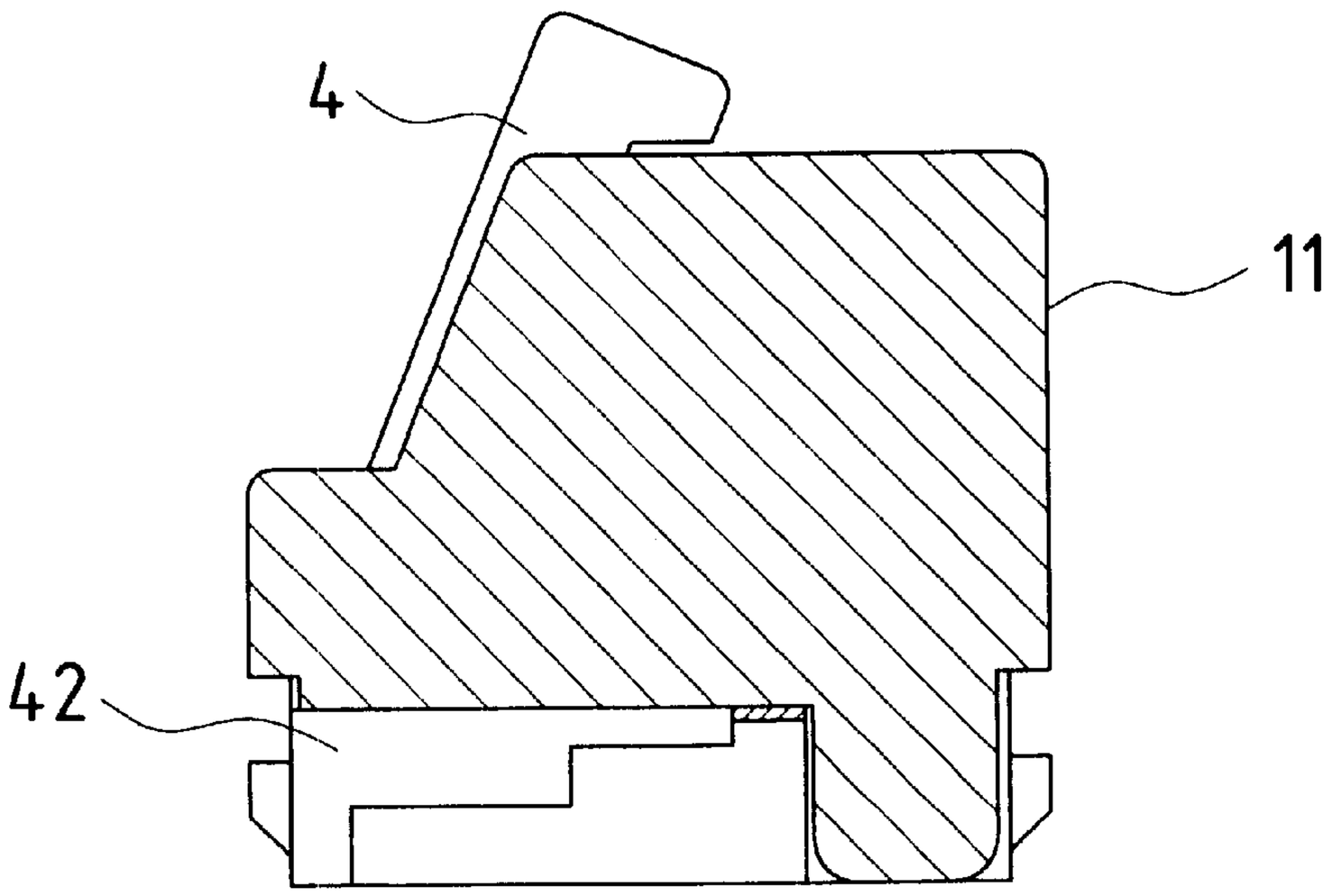


Fig.13

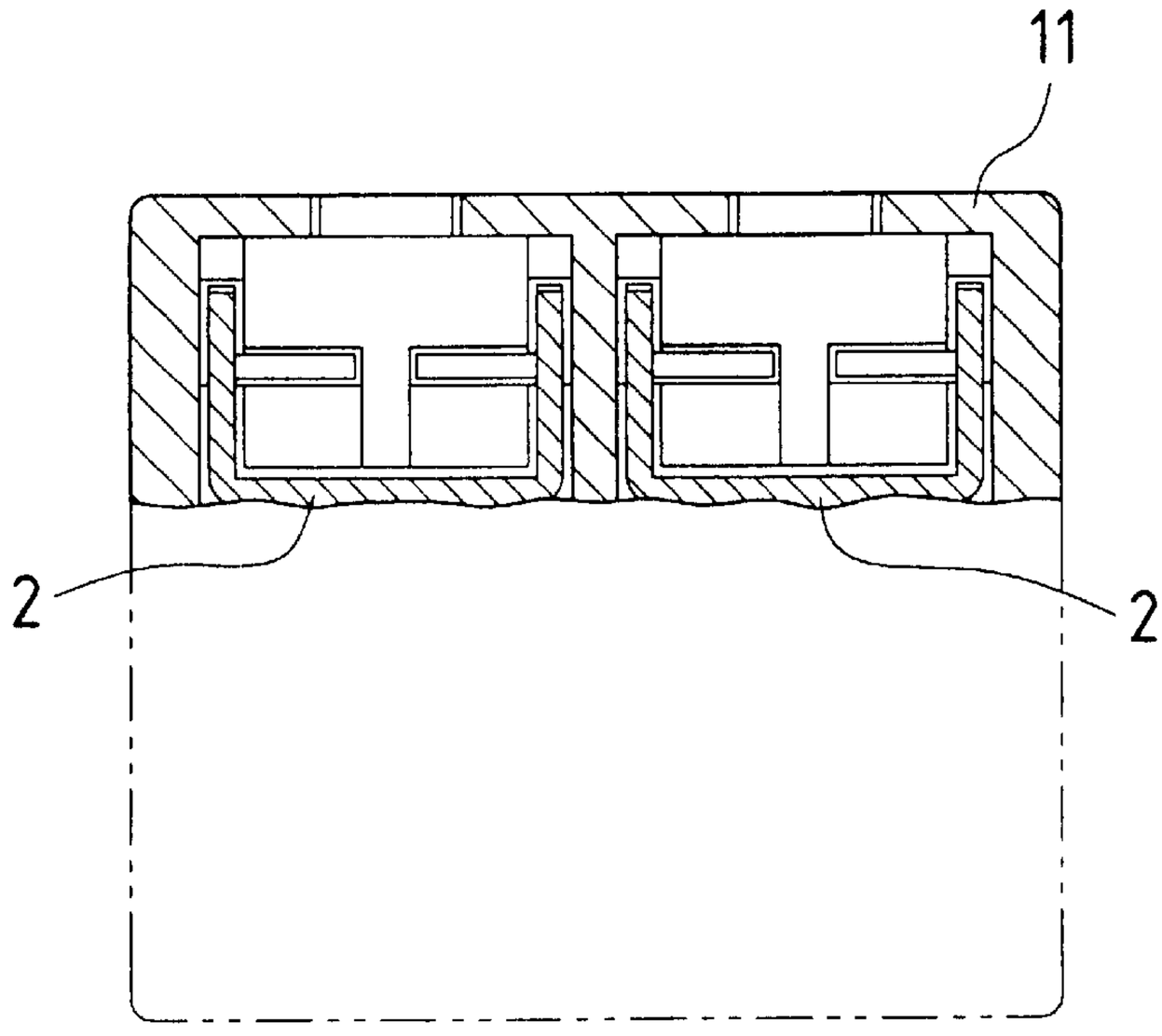


Fig.14

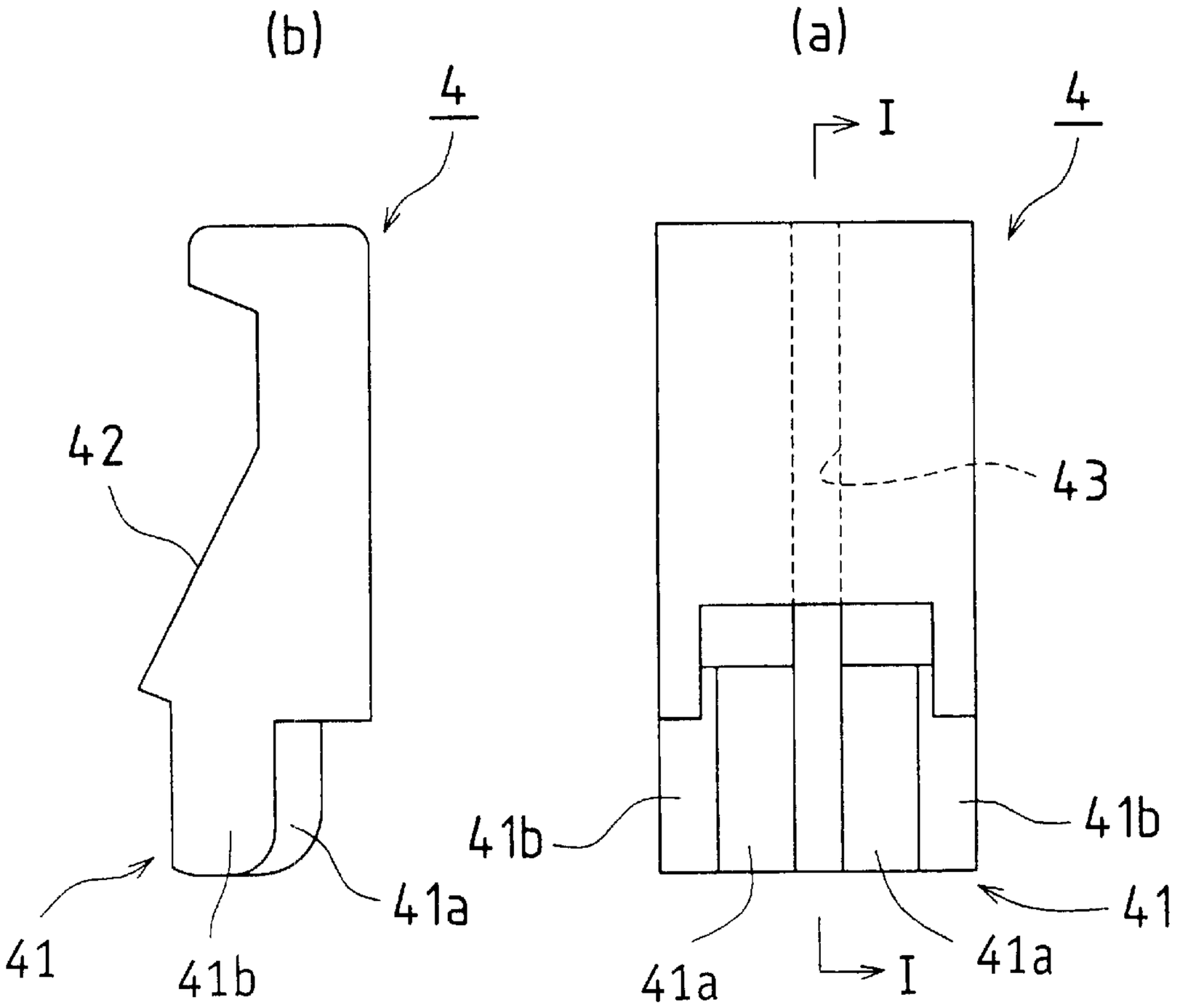


Fig.15

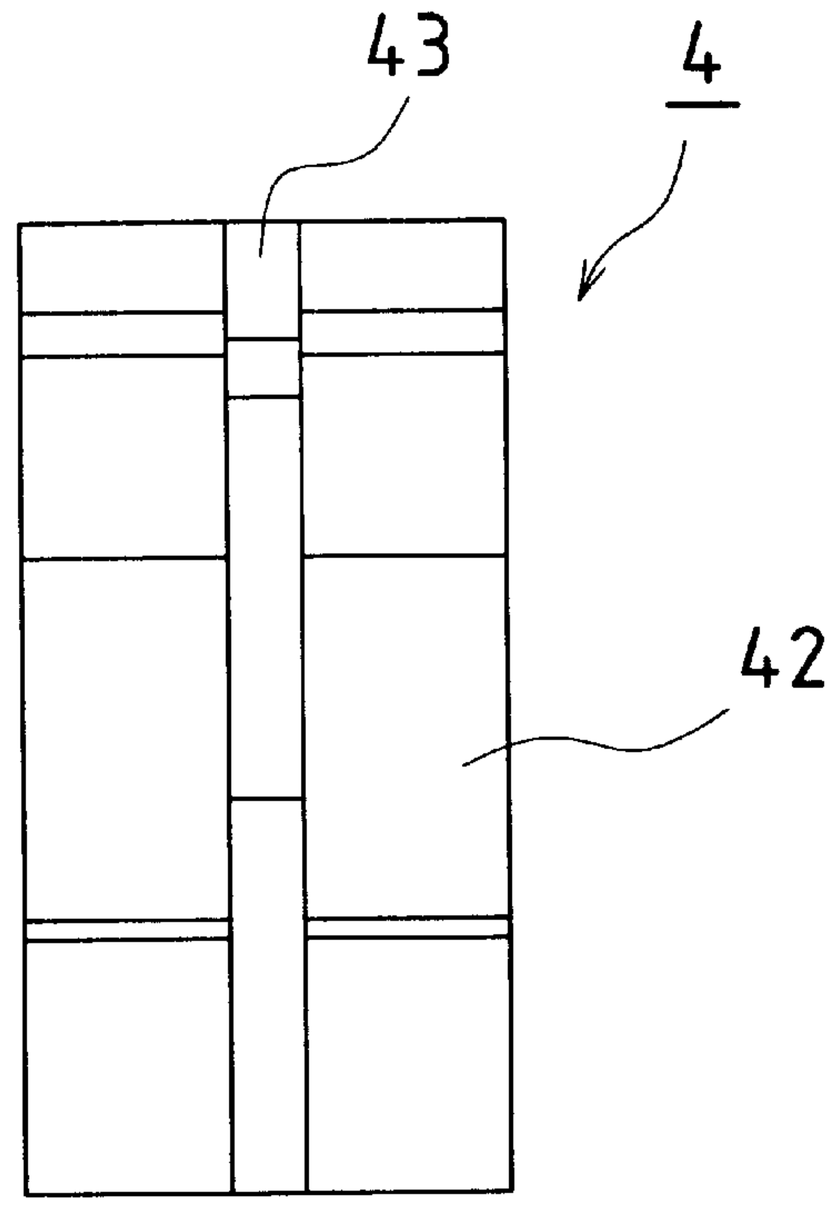


Fig.16

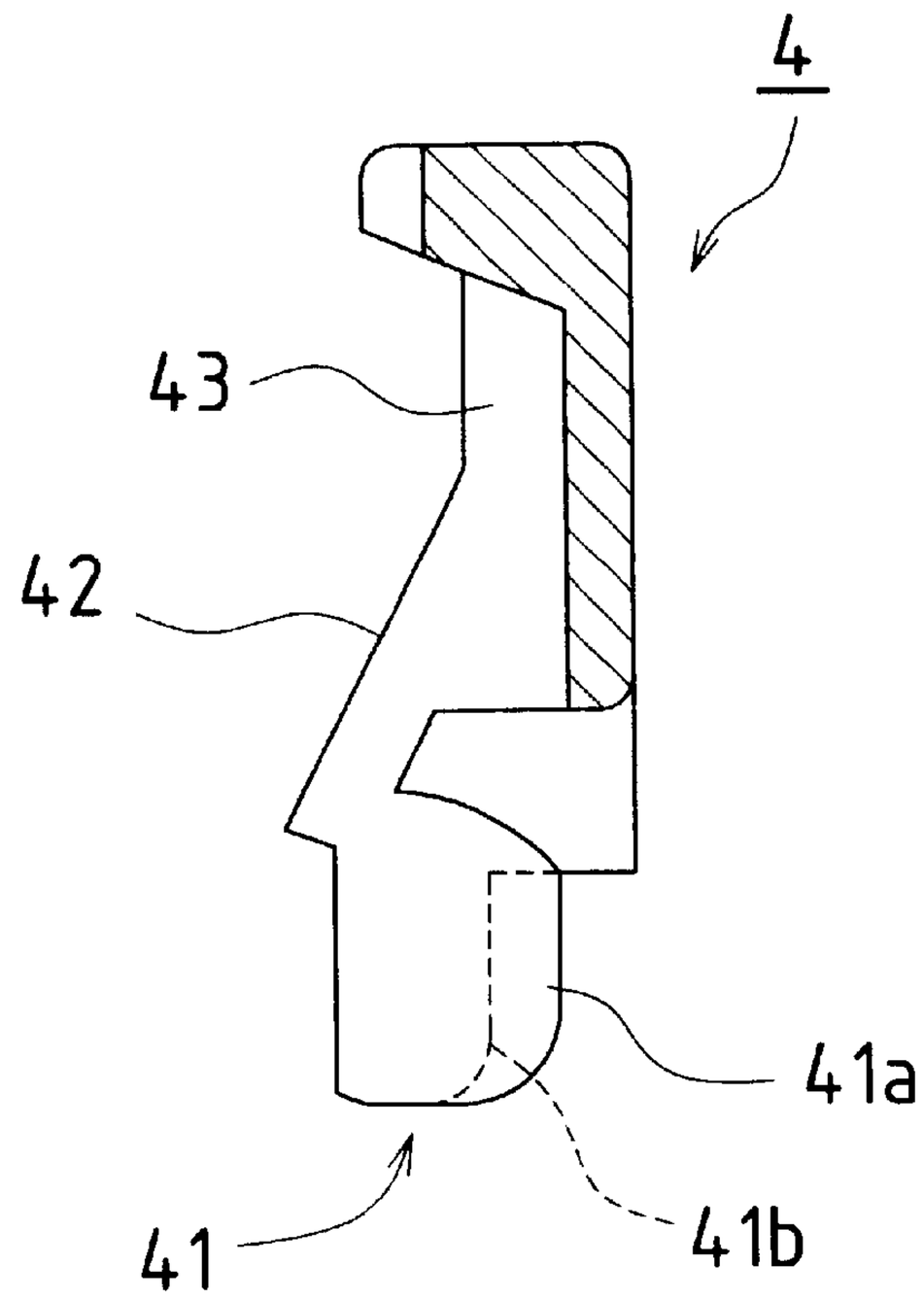


Fig.17

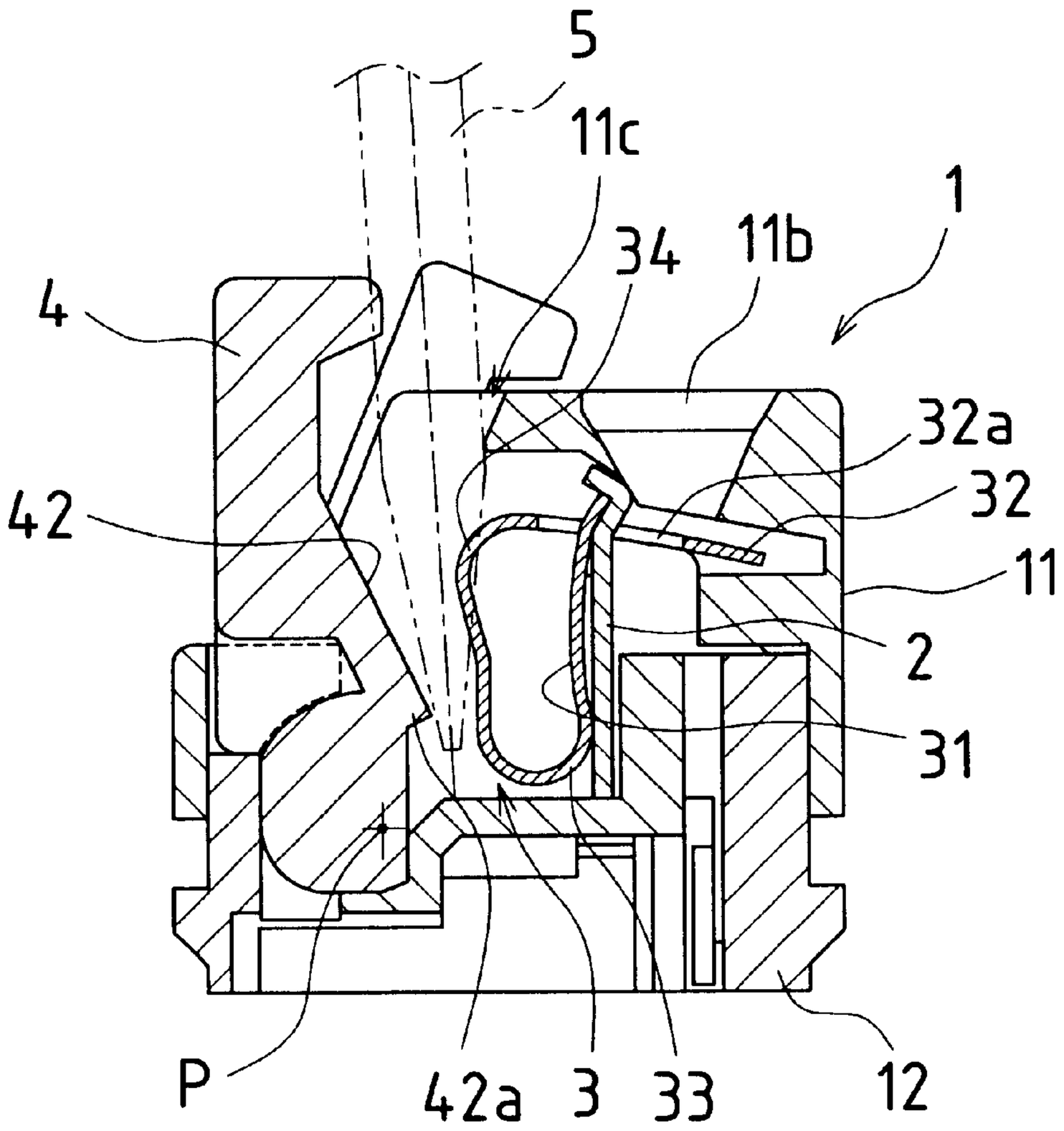


Fig.18

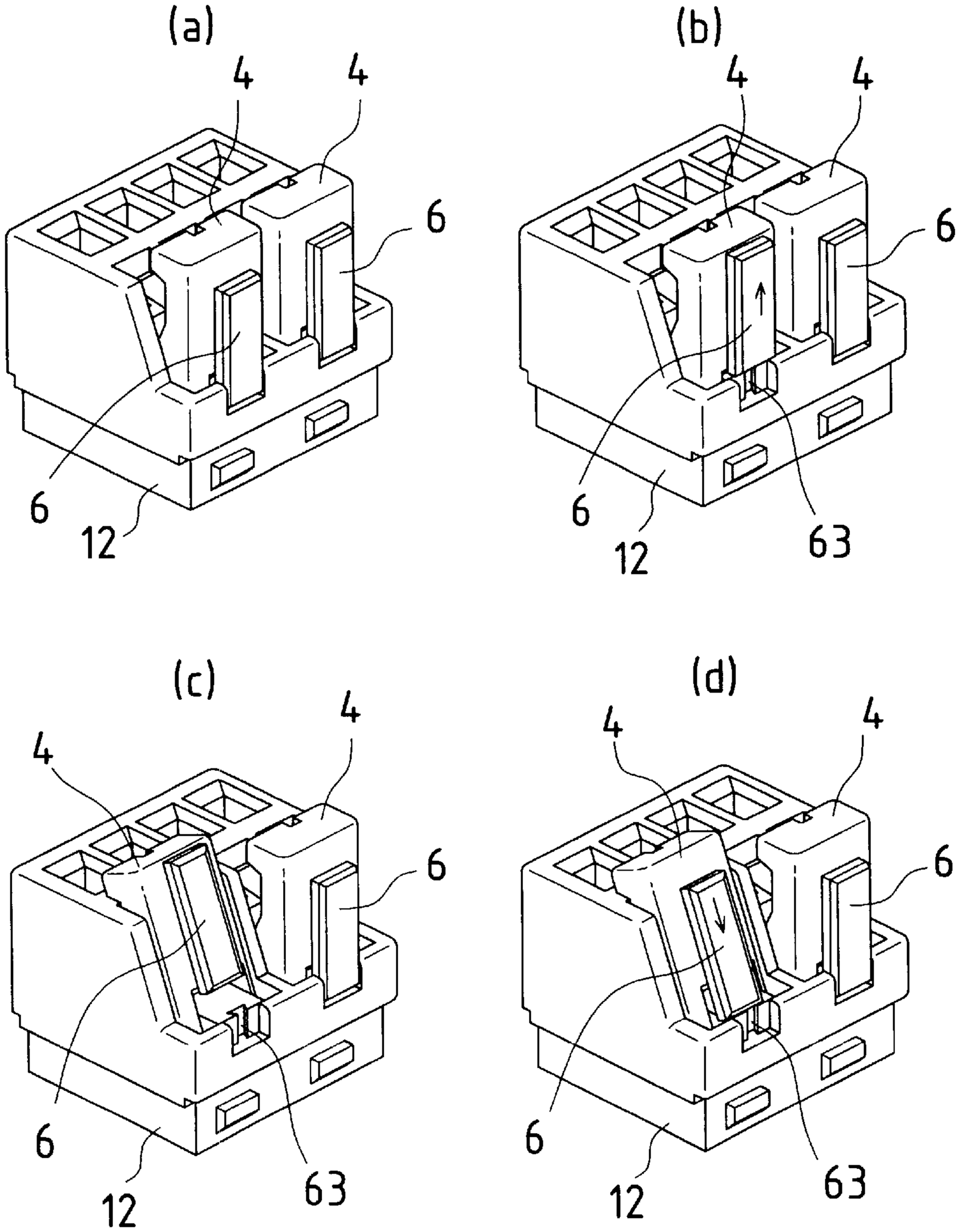


Fig.19

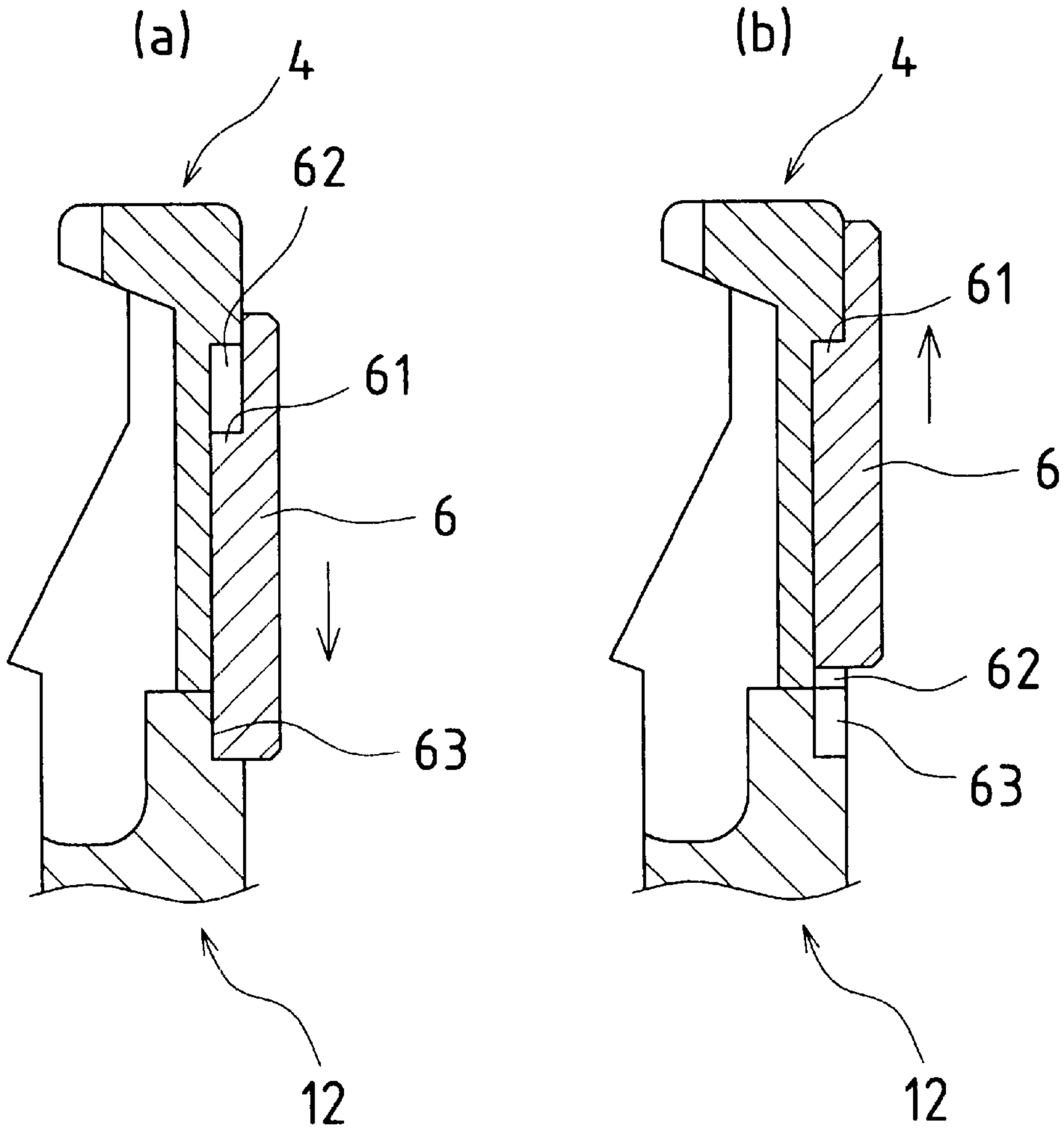


Fig.20

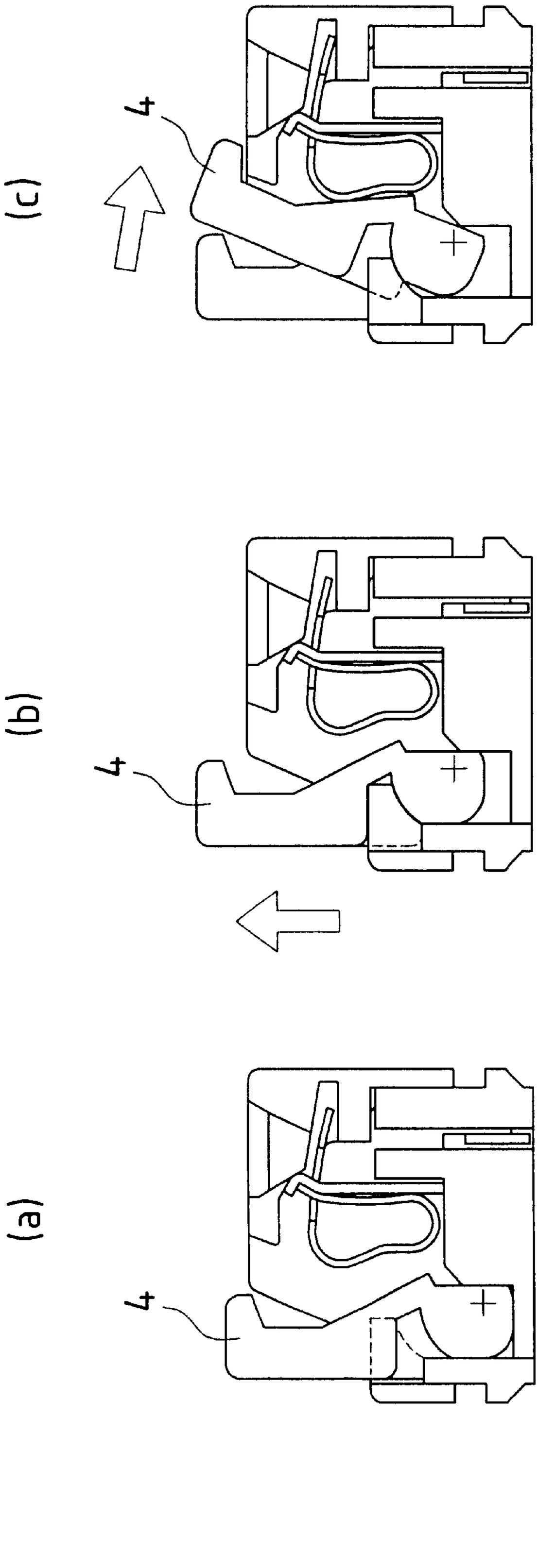


Fig.21

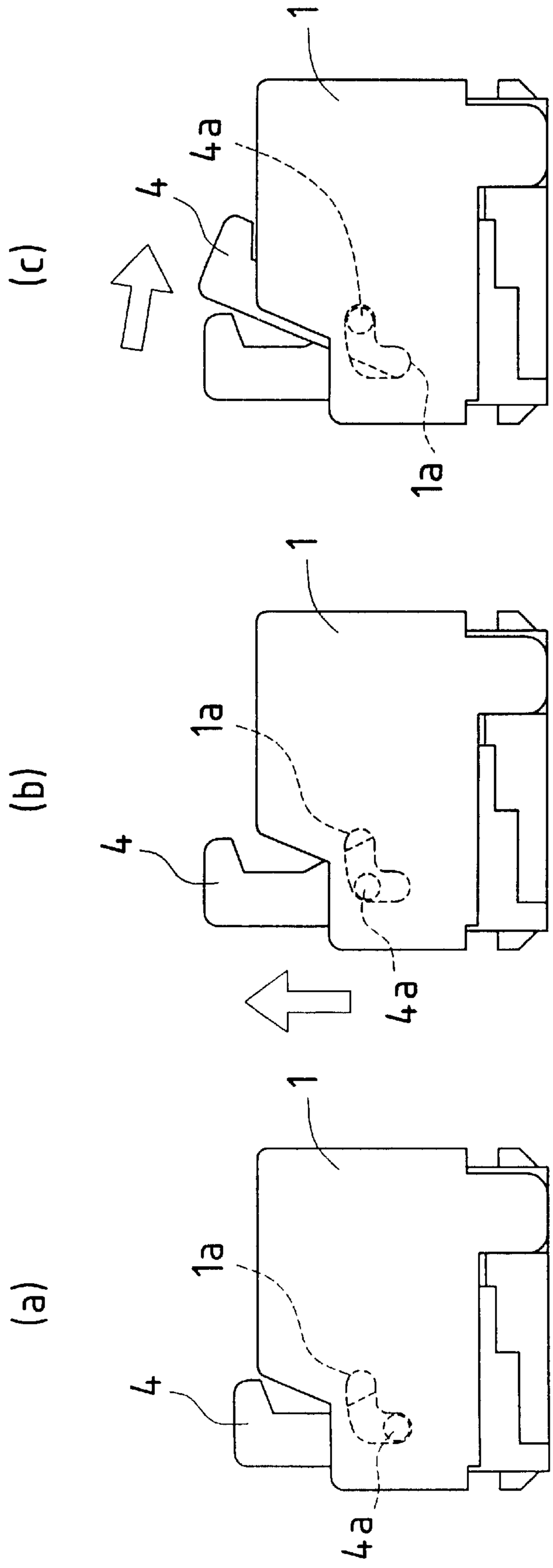
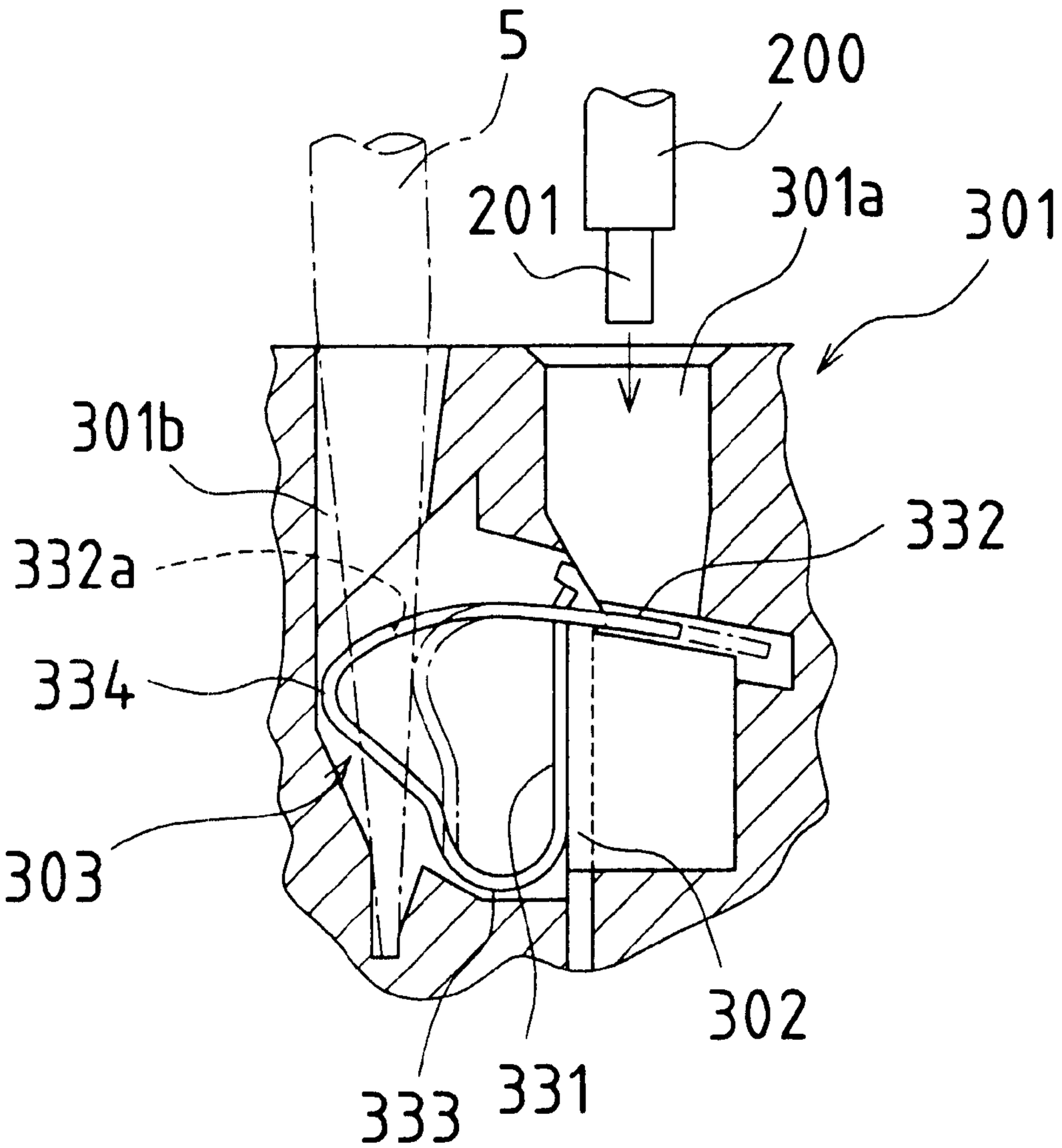


Fig.22
PRIOR ART



CONNECTION DEVICE

TECHNICAL FIELD

The present invention relates to a connector which is used at an electric wire connection for electric equipment (e.g. a control unit, a switch), a terminal block, etc.

BACKGROUND ART

A connector with a locking spring has been applied at an electric wire connection for electric equipment, etc. FIG. **22** shows an example of this connector.

Regarding this example, a locking spring **303** is a lock-like component made of a strip of plate spring. In this component, a fixed piece **331** is combined with a movable piece **332**, via a resilient transformed part **333** and a pushing part **334**. The tip of the fixed piece **331** is inserted into and latched with a connection hole **332***a* formed in the movable piece **332**. The fixed piece **331** of the locking spring **303** is secured on a terminal fitting **302** which is accommodated in a case **301**.

The case **301** has a wire slot **301***a* and a tool entrance **301***b*. When the tip of a screwdriver **5** is inserted in the tool entrance **301***b* to press the pushing part **334** of the locking spring **303**, the locking spring **303** is made to deflect such that the connection hole **332***a* in the movable piece **332** faces the wire slot **301***a*. In this state, an electric wire **200** is inserted in the wire slot **301***a*, allowing a conductor **201** at the leading end to enter the connection hole **332***a* The screwdriver **5** is pulled out at this stage. Then, owing to the resilience of the locking spring **303**, the conductor **201** of the electric wire **200** is pinched between the terminal fitting **302** and an edge of the connection hole **332***a*. Eventually, the conductor **201** is connected to the terminal fitting **302**.

It should be noted that the conventional connector illustrated in FIG. **20** requires a screwdriver or other tool in order to carry out the connecting operation.

Taking such circumstances into consideration, the present invention intends to provide a connector which can simplify wire connecting operations by not using a screwdriver or other tool, and which still enables the use of a screwdriver or other tool in wire connecting operations, when necessary.

DISCLOSURE OF THE INVENTION

A connector of the present invention is characterized in comprising: a locking spring which is a lock-like component made of a strip of plate spring, in which a fixed piece is combined with a movable piece via a resilient transformed part and a pushing part, and in which a tip of the fixed piece is inserted into a connection hole formed in the movable piece; a case for accommodating the locking spring; a terminal fitting which locates on an outer surface of the fixed piece of the locking spring; a wire slot formed opposite to the movable piece of the locking spring; and a lever which locates in an opening of the case and which serves to press the pushing part of the locking spring. This connector is also characterized in that the connection hole faces the wire slot, when the pushing part of the locking spring is pressed by operating the lever. The connector is further characterized in that, when the lever is in a non-operative position, a tool entrance is provided at the opening in such a manner that the tool entrance leads to a contact area where the lever meets the pushing part of the locking spring.

In the connector of the present invention, the lever may be provided with a locking mechanism for preventing accidental operations.

This locking mechanism may comprise a slidable stopper provided on the lever and a latch part provided on the case for latching the stopper, so that the lever can be fixed at a predetermined position by latching the stopper on the latch part.

In another locking mechanism, the lever may be designed upwardly slidable. When this lever is made to slide to a predetermined position, the locking mechanism is arranged to release the locked state and to make the lever rotatable.

In an alternative locking mechanism, the lever may be designed upwardly slidable. When this lever is made to slide to a predetermined position, the locking mechanism is arranged to make the lever swingable. Besides, the resulting swinging movement is arranged to cause the release of the locked state and to make the lever rotatable.

According to the connector of the present invention, wire connecting operations can be carried out simply by operating the lever with a finger, etc., instead of using a screwdriver or other tool. Besides, while the lever is in the non-operative position, the connector provides a tool entrance at the case opening for accepting the lever, such that the tool entrance leads to a contact area where the lever meets the pushing part of the locking spring. This tool entrance enables the use of a screwdriver or other tool in wire connecting operations.

Hence, this connector is adaptable to wire connecting operations at various places, including a narrow space where the lever cannot be operated with a finger, etc. For example, if the space is limited, an electric wire can be connected by means of a screwdriver.

Further, the tool entrance locates at the opening for accepting the lever, and the lever serves as a fulcrum for operating the screwdriver. This structure can dispense with a separate tool entrance, and helps to achieve the above effects in a space-saving environment.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** to FIG. **4** are perspective views of an embodiment of the present invention.

FIG. **5** is a plan view of the embodiment of the present invention.

FIG. **6** is a sectional view taken along the line A—A in FIG. **5**.

FIG. **7** is a sectional view taken along the line B—B in FIG. **5**.

FIG. **8** is a sectional view taken along the line C—C in FIG. **5**.

FIG. **9** is a sectional view taken along the line D—D in FIG. **5**.

FIG. **10** is a sectional view taken along the line E—E in FIG. **5**.

FIG. **11** is a sectional view taken along the line F—F in FIG. **5**.

FIG. **12** is a sectional view taken along the line G—G in FIG. **5**.

FIG. **13** is a sectional view taken along the line H—H in FIG. **6**.

FIG. **14**(*a*) is a front view of a lever used in the embodiment of the present invention. FIG. **14**(*b*) is a side view thereof.

FIG. **15** is a rear view of the lever.

FIG. **16** is a sectional view taken along the line I—I in FIG. **14**.

FIG. **17** illustrates an operation of the embodiment of the present invention.

FIG. **18** shows perspective views of another embodiment of the present invention.

FIG. **19** provides sectional views showing the essential structure of this embodiment.

FIGS. **20**(*a*)-(*c*) are sectional views illustrating an embodiment having a two-step operation structure.

FIGS. **21**(*a*)-(*c*) are sectional views illustrating an embodiment having another locking mechanism.

FIG. **22** illustrates an example of a conventional connector.

BEST MODE FOR CARRYING OUT THE INVENTION

Embodiments of the present invention are hereinafter described with reference to the drawings.

FIG. **1** to FIG. **4** are perspective views of an embodiment of the present invention. Among them, FIG. **3** and FIG. **4** provide the views where a top case **11** is removed.

FIG. **5** is a plan view of the embodiment of the present invention. FIG. **6** to FIG. **12** are sectional views taken along the lines A—A to G—G in FIG. **5**, respectively. FIG. **13** is a sectional view taken along the line H—H in FIG. **6**.

A connector of this embodiment is mainly composed of a case **1**, two terminal fittings **2**, **2**, four locking springs **3** . . . **3**, and two levers **4**, **4**.

The case **1** is made of a resin molded article (e.g. polyamide). It is composed of a top case **11** having two openings **11***a*, **11***a* for accepting the levers, and a bottom case **12** integrated with the top case **11** in the manner described below.

The top case **11** is formed with latch holes **11***e* and latch recesses **11***f*. The bottom case **12** is provided with latch pawls **12***a*, **12***b* which locate in correspondence with the latch holes lie and latch recesses **11***f* in the top case **11**. By engaging the latch holes **11***e* and latch recesses **11***f* with the latch pawls **12***a*, **12***b*, the top case **11** and the bottom case **12** are integrated with each other.

In the top case **11**, wire slots **11***b* . . . **11***b* situate opposite to respective movable pieces **32** of the four locking springs **3** . . . **3** to be mentioned below. In addition, a guiding plate **11***g* is furnished in the middle of each opening **11***a* in the top case **11**.

The bottom case **12** contains a bearing recess **121** which holds a rotatable support **41** of each lever **4** to be described later. The bearing recess **121** is composed of a fitting hole **121***a* and an arc-shaped guiding surface **121***b*.

Each of the terminal fittings **2** is an approximately channel-shaped component obtained by bending a metal plate (e.g. brass). The front end of the terminal fitting **2** is furnished with two latch pawls **21**, **21**, and the rear end constitutes a terminal plate **22**. As illustrated in FIG. **9** and FIG. **11**, each terminal fitting **2** is fixed on the bottom case **12** by inserting the terminal plate **22** into a through-hole lid formed in the bottom case **12**.

Each of the locking springs **3** is a lock-like component made of a strip of plate spring (e.g. stainless steel plate spring). A fixed piece **31** is combined with a movable piece **32**, via a resilient transformed part **33** and a pushing part **34**. A connection hole **32***a* is formed in the movable piece **32**. The tip of the fixed piece **31** is inserted into and latched with the connection hole **32***a*.

Each terminal fitting **2** is equipped with two locking springs **3**. To fix these locking spring **3** on the terminal fitting **2**, the latch pawls **21** of the terminal fitting **2** are interposed between the movable pieces **32** and edges of the connection holes **32***a*, with the outer surfaces (the surfaces not facing the pushing parts **34**) of the fixed pieces **31** abutting on the terminal fitting **2**.

Each lever **4** is made of a resin molded article (e.g. polyamide). As illustrated in FIG. **14** to FIG. **16**, one end (bottom end) of the lever **4** constitutes a rotatable support **41**. The inner side of the lever **4** is defined by an inclined surface **42** for pressing the pushing part **34** of the locking spring **3**. In addition, a slit groove **43** extends longitudinally in the middle of the inner side of the lever **4**.

The rotatable support **41** of the lever **4** has a stepped structure composed of a fitting projection **41***a* and guiding portions **41***b* formed on both sides thereof. To mount the rotatable support **41** in the bottom case **12**, the fitting projection **41***a* is fitted into the fitting hole **121***a* in the bearing recess **121** of the bottom case **12**. In this mounting state, the lever **4** held in the bottom case **12** is rotatable around the point P (FIG. **11**).

According to this embodiment, when the lever **4** is in a vertical posture relative to the bottom case **12**, as shown in FIG. **9**, a restriction surface **44** of the lever **4** contacts a restriction surface **122** of the bottom case **12**, thereby limiting outward rotation of the lever **4**. If the lever **4** in the vertical posture is depressed against the resilience of the locking springs **3**, the locking springs **3** are made to deflect such that the connection holes **32***a* in the movable pieces **32** are positioned face to face with the wire slots **11***b*.

Additionally, while the lever **4** is in the vertical posture (non-operative position), the inclined surface **42** of the lever **4** contacts the pushing parts **34** of the locking springs **3**. At the same time, tool entrances **11***c*, **11***c* are defined between the lever **4** and the top case **11** (the opening **11***a* for accepting the lever), with each entrance locating opposite to the respective locking spring **3**. Through either of these tool entrances **11***c*, **11***c*, the tip of the screwdriver **5** can enter as far as the contact area where the inclined surface **42** of the lever **4** meets the pushing part **34** of the locking spring **3** (see FIG. **17**).

The present embodiment is used in the following manner. For this description, reference can be made to FIG. **1** to FIG. **13** and FIG. **17**.

For the purpose of preparation, electric wires **200** for connection have their insulative coating layers **202** stripped, and thereby have their conductors **201** exposed (see FIG. **6**).

Secondly, as depicted in FIG. **6** and FIG. **8**, while the lever **4** is depressed with a finger or the like against the resilience of the locking springs **3**, the electric wires **200** are inserted into the wire slots **11***b*. After the conductors **201** pass through the connection holes **32***a* in the locking springs **3**, depression of the lever **4** is released. Then, due to the resilience of the locking springs **3**, the conductors **201** of the electric wires **200** are pinched between the terminal fitting **2** and the edges of the connection holes **32***a*, so that the conductors **201** are connected to the terminal fitting **2**. At the same time, the resilience of the locking springs **3** returns the lever **4** to the vertical posture.

In this connected state, the electric wires **200** can be disconnected from the terminal fitting **2** by pulling the electric wires **200** out of the wire slots **11***b*, while the lever **4** is kept depressed against the resilience of the locking springs **3**.

In the case of this embodiment, the tool entrances **11***c* are defined between the top case **11** and the lever **4** in the vertical posture (non-operative position). Each of these tool entrances **11***c* enables the use of a screwdriver **5** in wire connecting operations.

To be specific, as shown in FIG. **17**, the screwdriver **5** is inserted through each tool entrance **11***c*, forcing the tip of the screwdriver in between the inclined surface **42** of the lever **4** and the pushing part **34** of the locking spring **3**. At this moment, utilizing a corner **42***a* of the inclined surface **42** of the lever **4** as the fulcrum, the screwdriver **5** presses the pushing part **34** of the locking spring **3**, so that the locking spring **3** is made to deflect in the same manner as operated by the lever **4**. In this state where the connection hole **32***a* in the locking spring **3** locates face to face with the wire slot **11***b*, the conductor **201** of the electric wire **200** is inserted into the connection hole **32***a* in the locking spring **3**. The screwdriver **5** is pulled out of the tool entrance **11***c* at this stage. Then, owing to the resilience of the locking spring **3**, the conductor **201** of the electric wire **200** is pinched between the terminal fitting **2** and the edge of the connection hole **32***a*. Eventually, the conductor **201** is connected to the terminal fitting **2**.

Referring to FIG. **18** and FIG. **19**, the next description relates to another embodiment which is equipped with a locking mechanism for preventing accidental operations.

In a connector of this embodiment, each lever **4** is formed with a dovetail groove **62** which runs in the middle of its front surface. A dovetail groove **63** provided in the bottom case **12** can align with the dovetail groove **62** in the lever **4**, when the lever **4** is in the vertical posture. The lever **4** is also equipped with a stopper **6**. The stopper **6** has a dovetail tenon **61** which is fittable in the dovetail grooves **62**, **63**, whereby the stopper **6** can slide along the dovetail grooves **62**, **63**.

According to this embodiment, if the lever **4** is in the vertical posture and the stopper **6** is moved downwards in the drawing (FIG. **18**(*a*) and FIG. **19**(*a*)), the dovetail tenon **61** of the stopper **6** fits into the dovetail groove **63** in the bottom case **12**. In this state, rotation of the lever **4** is prohibited (the locked state for preventing accidental operations).

Under the locked state for preventing accidental operations, if the stopper is made to slide upwards (FIG. **18**(*b*) and FIG. **19**(*b*)), the dovetail tenon **61** of the stopper **6** comes out of the dovetail groove **63** in the bottom case **12**. Then, the lever **4** is ready to rotate (lock release).

While the lock is released, the lever **4** is depressed and tilted at an angle (FIG. **18**(*c*)). In order to keep the lever **4** locked in the operable open state, the stopper **6** is made to slide downwards, such that the dovetail tenon **61** of the stopper **6** is latched at the upper end of the dovetail groove **63** in the bottom case **12** (FIG. **18**(*d*)).

In this operably locked state, the conductors **201** of the electric wires **200** are inserted through the connection holes **32***a* in the locking springs **3** in the above-mentioned manner (see FIG. **6**). After insertion, the lock on the lever **4** is released by sliding the stopper **6** upwards. As a result, the resilience of the locking springs **3** serves to connect the conductors **201** to the terminal fitting **2**, while returning the lever **4** to the vertical posture. Later, the stopper **6** is made to slide downwards, thereby limiting the rotation of the lever **4** and preventing accidental operations.

With the provision of the above-mentioned locking mechanism, it is no longer necessary to keep the lever **4** depressed until the conductors **201** of the electric wires **200** enter the connection holes **32***a* in the locking springs **3**. This structure further facilitates wire connecting operations.

With respect to the embodiment shown in FIG. **18** and FIG. **19**, the locking mechanism relies on the vertically slidable stopper **6**. However, the locking mechanism should not be limited to such mode. As another adoptable locking mechanism, a stopper may be slidable in the horizontal directions. In this case, a dovetail groove in the bottom case **12** is designed in the sliding directions of the stopper. When the lever **4** is in the vertical posture, this dovetail groove is arranged to align with a dovetail groove in the lever **4**. Such a locking mechanism can lock/unlock the lever **4** in the same manner as above.

In addition, as shown in FIG. **20**, accidental operations of the lever **4** can be prevented by other structures such as a two-step operation structure (slide and rotate). According to this structure, when the lever **4** in the non-operative position is made to slide upwards to a predetermined position, the locked state is released to make the lever **4** rotatable.

As still another locking mechanism, as shown in FIG. **21**, the lever **4** is provided with a projection **4***a* on its lateral side facing the case **1**, whereas the case **1** is formed with a groove **1***a* which can fit with the projection **4***a* in order to make the lever **4** slidable. The lever **4** in the non-operative position becomes swingable, when the lever **4** is made to slide upwards to a predetermined position. In turn, the swinging movement displaces the projection to a predetermined position. As a result, the locked state is released to make the lever **4** rotatable.

Incidentally, although each connector mentioned in the above embodiments is equipped with two terminal fittings, the number of the terminal fittings may be one or more than two. Likewise, while each terminal fitting is equipped with two locking springs, the number of the locking springs may be one or more than two.

Further, each of the above embodiments is concerned with an independent connector. Nevertheless, the connector of the present invention may be incorporated within a control unit, a switch, etc.

INDUSTRIAL APPLICABILITY

As has been described, the connector of the present invention is applicable to an electric wire connection for electric equipment (e.g. a control unit, a switch), a terminal block, etc. According to this connector, wire connecting operations can be carried out in a simple manner, without using a screwdriver or other tool. Additionally, a screwdriver may be used to connect an electric wire in a narrow space where the lever cannot be operated by a finger, etc. Thus, this connector is useful for its flexible applicability, being applicable to electric wire connecting operations in various places including a place with a limited space.

What is claimed is:

1. A connector characterized in comprising:

a locking spring which is a lock-like component made of a strip of plate spring, in which a fixed piece is combined with a movable piece via a resilient transformed part and a pushing part, and in which a tip of the fixed piece is inserted into a connection hole formed in the movable piece;

a case for accommodating the locking spring;

a terminal fitting which locates on an outer surface of the fixed piece of the locking spring;

a wire slot formed in a predetermined area on the case, opposite to the movable piece of the locking spring; and

a lever which locates in an opening of the case and which serves to press the pushing part of the locking spring;

also characterized in:

that the connection hole faces the wire slot, when the pushing part of the locking spring is pressed by operating the lever,

that, when the lever is in a non-operative position, a tool entrance is provided at the opening in such a manner that the tool entrance leads to a contact area where the lever meets the pushing part of the locking spring, and

that the lever is provided with a locking mechanism for preventing rotation of the lever.

2. A connector according to claim **1**, characterized in that the locking mechanism comprises a slidable stopper provided on the lever and a latch part provided on the case for latching the stopper, so that the lever can be fixed at a predetermined position by latching the stopper on the latch part.

3. A connector according to claim **1**, characterized in that the lever is arranged to be slidable from the non-operative position to a predetermined position in order to switch from the locked state to the unlocked state, and that, when the lever is made to slide to a predetermined position, the locking mechanism releases the locked state and makes the lever rotatable.

4. A connector according to claim **1**, characterized in that the lever is arranged to be slidable from the non-operative position to a predetermined position in order to switch from the locked state to the unlocked state, and that, when the lever is made to slide to a predetermined position, the locking mechanism makes the lever swingable and the resulting swinging movement causes release of the locked state and makes the lever rotatable.

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